Remarks

Claims 1-30 are now pending in this application. Claims 1-28 stand rejected. Claims 29 and 30 have been newly added. A fee calculation sheet for the newly added claims along with authorization to charge a deposit account in the amount of the calculated fee are submitted herewith.

The objection to the Abstract is respectfully traversed. The Abstract has been amended and is submitted to be in the proper language and format for an Abstract. For the reason set forth above, Applicants respectfully request that the objection to the Abstract be withdrawn.

The objection to the disclosure under 37 CFR 1.71 is respectfully traversed. Equation (7a) has been amended to correct a typographical error. Further, Applicants respectfully submit that the specification describes the mathematical algorithm and the manner of use as to enable an artisan of ordinary skill in the art of computing an approximation of a natural logarithm function to practice the invention. For the reasons cited above, Applicants submit that the specification is in condition for allowance.

The rejection of Claims 1-28 under 35 U.S.C. § 112, second paragraph, is respectfully traversed. Specifically, independent Claim 1 in part recites "[a] method for computing an approximation of a natural logarithm function", and Claim 15 in part recites "compute an approximation value of log(x). Applicants respectfully submit that Claims 1-28 particularly point out and distinctly claim the subject matter the Applicants regard as the invention. Further, Applicants respectfully traverse the assertion in the Office Action that the scientific notation for natural log is only ln(x). Rather, as is known in the art, mathematicians commonly use the notation log(x) to denote the natural log. Further the specification at page 5, line 7 defines a negative natural log function as –log(x) in accordance with the standard notation used by mathematicians. For the reasons set forth above, Applicants respectfully request that the Section 112 rejection of Claims 1-28 be withdrawn.

The rejection of Claims 1-7 and 15-21 under 35 U.S.C. §101 is respectfully traversed.

In reviewing patent applications for compliance with the utility requirement of 35 U.S.C. 101, office personnel must review both the specification and the claims to determine whether the Applicant has asserted any credible utility for the claimed invention. The asserted utility need not be recited in the claims. MPEP 706.03(a)(1). Therefore, a rejection based on lack of utility cannot be maintained if the Applicant has asserted even one credible utility in the specification or the claims, as judged by a person of ordinary skill in the art.

Here, Applicants have asserted at least one credible utility, a method for computing an approximation of a natural logarithm function. Applicants respectfully traverse the assertion in the Office Action that the claims must include either a step or means that results in a physical transformation outside the computer or a limitation to a practical application. Rather, the U.S. Court of Appeals Federal Circuit has addressed the issue of patentable subject matter. *State Street Bank & Trust Co. v. Signature Financial Group* teaches that the question of whether a claim encompasses statutory subject matter under 35 U.S.C. 101 should focus on the practical utility of the invention. *State Street Bank & Trust Co. v. Signature Financial Group*, 47 U.S.P.Q2d 1596, 1602 (Fed. Cir. 1998). More specifically, the court ruled that claims directed toward a system including a processor programmed to perform mathematical calculations as steps of a method that produces a useful, concrete and tangible result do constitute statutory subject matter under 35 U.S.C. 101. *State Street Bank & Trust Co. v. Signature Financial Group*, 47 U.S.P.Q2d 1596 (Fed. Cir. 1998). In addition, the court has explained that 35 U.S.C 101 is satisfied by claims to a system performing a particularly claimed combination of calculations to transform digital data into more useful output data. *In re Alapat*, 31 USPQ2d 1545, 1558 (Fed. Cir. 1994).

Here, the pending claims include recitations that clearly satisfy the rules of *State Street* and *In re Alapat*. In particular, Claim 1 is directed toward a method for computing an approximation of a natural logarithm. Independent Claim 15 recites a computing device

configured to compute an approximation value of log(x) for a binary floating point representation of a particular number x stored in said memory utilizing the first degree polynomial in m. Thus, Claims 1 and 15 recite a method and computing device configured to compute an approximation of a natural logarithm, and Claims 1 and 15 therefore satisfy the requirements of Section 101.

Claims 2-7 depend, either directly or indirectly, from independent Claim 1, and Claims 16-21 depend, either directly or indirectly, from independent Claim 15. When the recitations of Claims 2-7 and 16-21 are considered in combination with the recitations of Claims 1 and 15 respectively, Applicants submit that dependent Claims 2-7 and 16-21 are likewise patentable.

For the reasons set forth above, Applicants respectfully request that the Section 101 rejection of Claims 1-7 and 15-21 be withdrawn.

The rejection of Claims 1-3, 7, 15-17, and 21 under 35 U.S.C. § 103 as being unpatentable over Smith (U.S. Pat. No. 5,570,310) in view of Watson (U.S. Pat. No. 5,629,780) is respectfully traversed.

Smith describes a method for determining a $\log_p(x)$ wherein p is a numerical base and x is a floating point value. Smith also describes that to calculate a natural logarithm of a number x, a number y can be formed from the argument x by copying x to y and replacing the exponent field used for calculating the floating-point representation of y by the exponent field. The number y lies in one of $2^n +1$ intervals between 1 and 2. In other words, a number line can be represented where 1 is at the left side and 2 is at the right side and $2^n +1$ intervals divide this range into segments.

Watson describes a method for performing color or grayscale image compression using a Discrete Cosine Transform (DCT). Watson also describes that a storage mode (16) is segmented into the following steps: color transform (31), down-sample (32), block (33), DCT (34), initial matrices (35), quantization matrix optimizer (36), quantize (38), and entropy code (40). After the calculation of a DCT mask (70) has been determined, an iterative process of estimating the

quantization matrix operator (36) begins and includes processing segments (56, 58, 60, 62, 64, and 66). The quantization matrix optimizer transforms each block of the image in an initial matrix (35) into segments (56). A bisection method is then used to increment or decrement the initial matrices. In the bisection method, a range is established for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255. A perceptual error matrix $p_{u,v,\theta}$ is evaluated at midpoint of the range. If $p_{u,v,\theta}$ is greater than a target error parameter, then the lower bound is reset to the mid-point.

Applicants respectfully submit that the Section 103 rejection of the presently pending claims is not a proper rejection. Obviousness cannot be established by merely suggesting that it would have been obvious to one of ordinary skill in the art to modify Smith according to the teachings of the Watson. More specifically, as is well established, obviousness cannot be established by combining the teachings of the cited art to produce the claimed invention, absent some teaching, suggestion, or incentive supporting the combination. Rather, the present Section 103 rejection appears to be based on a combination of teachings selected from several patents in an attempt to arrive at the claimed invention. Specifically, Smith is cited for its teaching a method for determining a $\log_p(x)$ wherein p is a numerical base and x is a floating point value, and Watson is cited for its teaching that a bisection method is used to increment or decrement a matrix, wherein the bisection method includes establishing a range for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255, a perceptual error matrix $p_{u,v,\theta}$ is then evaluated at midpoint of the range. Since there is no teaching or suggestion in the cited art for the claimed combination, the Section 103 rejection appears to be based on a hindsight reconstruction in which isolated disclosures have been picked and chosen in an attempt to deprecate the present invention. Of course, such a combination is impermissible, and for this reason alone, Applicants respectfully request that the Section 103 rejection be withdrawn.

As the Federal Circuit has recognized, obviousness is not established merely by combining references having different individual elements of pending claims. Ex parte Levengood, 28 U.S.P.Q.2d 1300 (Bd. Pat. App. & Inter. 1993). MPEP 2143.01. Rather, there must be some suggestion, outside of Applicants' disclosure, in the prior art to combine such

references, and a reasonable expectation of success must be both found in the prior art, and not based on Applicant's disclosure. In re Vaeck, 20 U.S.P.Q.2d 1436 (Fed. Cir. 1991). In the present case, neither a suggestion nor motivation to combine the prior art disclosures, nor any reasonable expectation of success has been shown.

Applicants respectfully submit however, that a closer examination of the prior art would reveal that the prior art teaches away from the present invention. More specifically, neither Smith nor Watson considered alone or in combination, describe or suggest the claimed combination, and as such, the presently pending claims are patentably distinguishable from the cited combination. Claim 1 recites a method for computing an approximation of a natural logarithm function that includes "partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions; precomputing centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$; selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes $\log(m)$ to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number; and computing a value of $\log(x)$ for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m."

Neither Smith nor Watson, considered alone or in combination, describe or suggest a method for computing an approximation of a natural logarithm function that includes partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions, precomputing centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$, selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes $\log(m)$ to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and computing a value of $\log(x)$ for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m. Moreover, neither Smith nor Watson, considered alone or in combination, describe or suggest "precomputing centerpoints a_i of each of the N

equally spaced sub-regions, where $i = 0,\ldots,N-1$, selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and computing a value of log(x) for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m." Rather, Smith describes a method for determining a $\log_p(x)$ wherein p is a numerical base and x is a floating point value, and Watson describes that a bisection method is used to increment or decrement a matrix, wherein the bisection method includes establishing a range for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255, a perceptual error matrix $p_{u,v,\theta}$ is then evaluated at midpoint of the range. For the reasons set forth above, Claim 1 is submitted to be patentable over Smith in view of Watson.

Claims 2-3, and 7 depend, directly or indirectly, from independent Claim 1. When the recitations of Claims 2-3, and 7 are considered in combination with the recitations of Claim 1, Applicants submit that dependent Claims 2-3, and 7 likewise are patentable over Smith in view of Watson.

Claim 15 recites a computing device including a memory in which binary floating point representations of particular numbers are stored, wherein the device is configured to "partition a mantissa region between 1 and 2 into N equally spaced sub-regions; precompute centerpoints a_i of each of the N equally spaced sub-regions, where i=0,...,N-1, wherein N is sufficiently large so that, within each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number; and compute a value of log(x) for a binary floating point representation of a particular number x stored in said memory utilizing the first degree polynomial in m."

Neither Smith nor Watson, considered alone or in combination, describe or suggest a computing device including a memory in which binary floating point representations of

particular numbers are stored, wherein the device is configured to partition a mantissa region between 1 and 2 into N equally spaced sub-regions, precompute centerpoints a_i of each of the N equally spaced sub-regions, where i=0,...,N-1, wherein N is sufficiently large so that, within each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and compute a value of log(x) for a binary floating point representation of a particular number x stored in said memory utilizing the first degree polynomial in m. Moreover, neither Smith nor Watson, considered alone or in combination, describe or suggest a computing device including a memory in which binary floating point representations of particular numbers are stored, wherein the device is configured to precompute centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots, N-1$, selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and compute a value of log(x) for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m. Rather, Smith describes a method for determining a $\log_p(x)$ wherein p is a numerical base and x is a floating point value, and Watson describes that a bisection method is used to increment or decrement a matrix, wherein the bisection method includes establishing a range for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255, a perceptual error matrix $p_{u,v,\theta}$ is then evaluated at midpoint of the range. For the reasons set forth above, Claim 15 is submitted to be patentable over Smith in view of Watson.

Claims 16-17, and 21 depend, directly or indirectly, from independent Claim 15. When the recitations of Claims 16-17, and 21 are considered in combination with the recitations of Claim 15, Applicants submit that dependent Claims 16-17, and 21 likewise are patentable over Smith in view of Watson.

For the reasons set forth above, Applicants respectfully request that the Section 103 rejections of Claims 1-3, 7, 15-17, and 21 be withdrawn.

The rejection of Claims 8-9 and 22-23 under 35 U.S.C. § 103 as being unpatentable over Smith (U.S. Pat. No. 5,570,310) in view of Wallschlaeger (U.S. Pat. No. 5,345,381) is respectfully traversed.

Smith is described above. Wallschlaeger describes a method for obtaining a computer tomogram of a patient (5) using a computed tomography apparatus. Wallschlaeger also describes that for systems using a spiral scan, interpolation algorithms have been developed which generate new data, by interpolation, corresponding to a planar slice from the spiral data before the actual image reconstruction. Interpolation algorithms are then used on the spiral data in the form of attenuation values. The attenuation values are scaled line integrals or scaled logarithms of the relative intensities.

Applicants respectfully submit that the Section 103 rejection of the presently pending claims is not a proper rejection. Obviousness cannot be established by merely suggesting that it would have been obvious to one of ordinary skill in the art to modify Smith according to the teachings of the Wallschlaeger. More specifically, as is well established, obviousness cannot be established by combining the teachings of the cited art to produce the claimed invention, absent some teaching, suggestion, or incentive supporting the combination. Rather, the present Section 103 rejection appears to be based on a combination of teachings selected from several patents in an attempt to arrive at the claimed invention. Specifically, Smith is cited for its teaching a method for determining a $\log_p(x)$ wherein p is a numerical base and x is a floating point value, and Wallschlaeger is cited for its teaching that attenuation values are scaled line integrals or scaled logarithms of the relative intensities. Since there is no teaching or suggestion in the cited art for the claimed combination, the Section 103 rejection appears to be based on a hindsight reconstruction in which isolated disclosures have been picked and chosen in an attempt to

deprecate the present invention. Of course, such a combination is impermissible, and for this reason alone, Applicants respectfully request that the Section 103 rejection be withdrawn.

As the Federal Circuit has recognized, obviousness is not established merely by combining references having different individual elements of pending claims. Ex parte Levengood, 28 U.S.P.Q.2d 1300 (Bd. Pat. App. & Inter. 1993). MPEP 2143.01. Rather, there must be some suggestion, outside of Applicants' disclosure, in the prior art to combine such references, and a reasonable expectation of success must be both found in the prior art, and not based on Applicant's disclosure. In re Vaeck, 20 U.S.P.Q.2d 1436 (Fed. Cir. 1991). In the present case, neither a suggestion nor motivation to combine the prior art disclosures, nor any reasonable expectation of success has been shown.

Applicants respectfully submit however, that a closer examination of the prior art would reveal that the prior art teaches away from the present invention. More specifically, neither Smith nor Wallschlaeger, considered alone or in combination, describe or suggest the claimed combination, and as such, the presently pending claims are patentably distinguishable from the cited combination. Claims 8-9 depend, either directly or indirectly, from independent Claim 1 which recites a method for computing an approximation of a natural logarithm function that includes "partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions; precomputing centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$; selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes $\log(m)$ to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number; and computing a value of $\log(x)$ for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m."

Neither Smith nor Wallschlaeger, considered alone or in combination, describe or suggest a method for computing an approximation of a natural logarithm function that includes partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions, precomputing

centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$, selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and computing a value of log(x) for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m. Moreover, neither Smith nor Wallschlaeger, considered alone or in combination, describe or suggest precomputing centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$, selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and computing a value of log(x) for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m. Rather, Smith describes a method for determining a $\log_p(x)$ wherein p is a numerical base and x is a floating point value, and Wallschlaeger describes that attenuation values are scaled line integrals or scaled logarithms of the relative intensities. For the reasons set forth above, Claim 1 is submitted to be patentable over Smith in view of Wallschlaeger.

Claims 8-9 depend, directly or indirectly, from independent Claim 1. When the recitations of Claims 8-9 are considered in combination with the recitations of Claim 1, Applicants submit that dependent Claims 8-9 likewise are patentable over Smith in view of Wallschlaeger.

Claims 22-23 depend, either directly or indirectly, from independent Claim 15 which recites a computing device including a memory in which binary floating point representations of particular numbers are stored, wherein the device is configured to "partition a mantissa region between 1 and 2 into N equally spaced sub-regions; precompute centerpoints a_i of each of the N equally spaced sub-regions, where i=0,...,N-1, wherein N is sufficiently large so that, within each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of

accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number; and compute a value of log(x) for a binary floating point representation of a particular number x stored in said memory utilizing the first degree polynomial in m."

Neither Smith nor Wallschlaeger, considered alone or in combination, describe or suggest a computing device including a memory in which binary floating point representations of particular numbers are stored, wherein the device is configured to partition a mantissa region between 1 and 2 into N equally spaced sub-regions, precompute centerpoints a_i of each of the N equally spaced sub-regions, where i=0,...,N-1, wherein N is sufficiently large so that, within each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and compute a value of log(x) for a binary floating point representation of a particular number x stored in said memory utilizing the first degree polynomial in m." Moreover, neither Smith nor Wallschlaeger, considered alone or in combination, describe or suggest a computing device including a memory in which binary floating point representations of particular numbers are stored, wherein the device is configured to precompute centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$, selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and compute a value of log(x) for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m. Rather, Smith describes a method for determining a $\log_p(x)$ wherein p is a numerical base and x is a floating point value, and Wallschlaeger describes that attenuation values are scaled line integrals or scaled logarithms of the relative intensities. For the reasons set forth above, Claim 15 is submitted to be patentable over Smith in view of Wallschlaeger.

Claims 22-23 depend, directly or indirectly, from independent Claim 15. When the recitations of Claims 22-23 are considered in combination with the recitations of Claim 15, Applicants submit that dependent Claims 22-23 likewise are patentable over Smith in view of Wallschlaeger.

For the reasons set forth above, Applicants respectfully request that the Section 103 rejections of Claims 8-9 and 22-23 be withdrawn.

The rejection of Claims 10-11 and 24-25 under 35 U.S.C. § 103 as being unpatentable over Smith (U.S. Pat. No. 5,570,310) in view of Wallschlaeger (U.S. Pat. No. 5,345,381) and further in view of Watson (U.S. Pat. No. 5,629,780) is respectfully traversed.

Smith, Wallschlaeger, and Watson are described above. Applicants respectfully submit that the Section 103 rejection of the presently pending claims is not a proper rejection. Obviousness cannot be established by merely suggesting that it would have been obvious to one of ordinary skill in the art to modify Smith according to the teachings of the Wallschlaeger and Watson. More specifically, as is well established, obviousness cannot be established by combining the teachings of the cited art to produce the claimed invention, absent some teaching, suggestion, or incentive supporting the combination. Rather, the present Section 103 rejection appears to be based on a combination of teachings selected from several patents in an attempt to arrive at the claimed invention. Specifically, Smith is cited for its teaching a method for determining a $\log_p(x)$ wherein p is a numerical base and x is a floating point value, and Wallschlaeger is cited for its teaching that attenuation values are scaled line integrals or scaled logarithms of the relative intensities, and Watson is cited for its teaching that a bisection method is used to increment or decrement a matrix, wherein the bisection method includes establishing a range for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255, a perceptual error matrix $p_{u,v,\theta}$ is then evaluated at midpoint of the range. Since there is no teaching or suggestion in the cited art for the claimed combination, the Section 103 rejection appears to be based on a hindsight reconstruction in which isolated disclosures have been picked and chosen in an attempt

to deprecate the present invention. Of course, such a combination is impermissible, and for this reason alone, Applicants respectfully request that the Section 103 rejection be withdrawn.

As the Federal Circuit has recognized, obviousness is not established merely by combining references having different individual elements of pending claims. Ex parte Levengood, 28 U.S.P.Q.2d 1300 (Bd. Pat. App. & Inter. 1993). MPEP 2143.01. Rather, there must be some suggestion, outside of Applicants' disclosure, in the prior art to combine such references, and a reasonable expectation of success must be both found in the prior art, and not based on Applicant's disclosure. In re Vaeck, 20 U.S.P.Q.2d 1436 (Fed. Cir. 1991). In the present case, neither a suggestion or motivation to combine the prior art disclosures, nor any reasonable expectation of success has been shown.

Applicants respectfully submit however, that a closer examination of the prior art would reveal that the prior art teaches away from the present invention. More specifically, none of Smith, Wallschlaeger, nor Watson, considered alone or in combination, describe or suggest the claimed combination, and as such, the presently pending claims are patentably distinguishable from the cited combination. Claims 10-11 depend, either directly or indirectly, from independent Claim 1 which recites a method for computing an approximation of a natural logarithm function that includes "partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions; precomputing centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$; selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes $\log(m)$ to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number; and computing a value of $\log(x)$ for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m."

None of Smith, Wallschlaeger, and Watson, considered alone or in combination, describe or suggest a method a method for computing an approximation of a natural logarithm function that includes partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions,

precomputing centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$, selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and computing a value of log(x) for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m. Moreover, none of Smith, Wallschlaeger, and Watson, considered alone or in combination, describe or suggest "precomputing centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$, selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and computing a value of log(x) for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m." Rather, Smith describes a method for determining a $\log_p(x)$ wherein p is a numerical base and x is a floating point value, Wallschlaeger describes that attenuation values are scaled line integrals or scaled logarithms of the relative intensities, and Watson describes that a bisection method is used to increment or decrement a matrix, wherein the bisection method includes establishing a range for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255, a perceptual error matrix $p_{u,v,\theta}$ is then evaluated at midpoint of the range. For the reasons set forth above, Claim 1 is submitted to be patentable over Smith in view of Wallschlaeger and further in view of Watson.

Claims 10-11 depend, directly or indirectly, from independent Claim 1. When the recitations of Claims 10-11 are considered in combination with the recitations of Claim 1, Applicants submit that dependent Claims 10-11 likewise are patentable over Smith in view of Wallschlaeger and further in view of Watson.

Claims 24-25 depend, either directly or indirectly, from independent Claim 15 which recites a computing device including a memory in which binary floating point representations of particular numbers are stored, wherein the device is configured to "partition a mantissa region

between 1 and 2 into N equally spaced sub-regions; precompute centerpoints a_i of each of the N equally spaced sub-regions, where i=0,...,N-1, wherein N is sufficiently large so that, within each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number; and compute a value of log(x) for a binary floating point representation of a particular number x stored in said memory utilizing the first degree polynomial in m."

None of Smith, Wallschlaeger, and Watson, considered alone or in combination, describe or suggest a computing device including a memory in which binary floating point representations of particular numbers are stored, wherein the device is configured to partition a mantissa region between 1 and 2 into N equally spaced sub-regions, precompute centerpoints a_i of each of the N equally spaced sub-regions, where i=0,...,N-1, wherein N is sufficiently large so that, within each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and compute a value of log(x) for a binary floating point representation of a particular number x stored in said memory utilizing the first degree polynomial in m. Moreover, none of Smith, Wallschlaeger, and Watson considered alone or in combination, describe or suggest a computing device including a memory in which binary floating point representations of particular numbers are stored, wherein the device is configured to precompute centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$, selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a number, and compute a value of log(x) for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m. Rather, Smith describes a method for determining a $\log_p(x)$ wherein p is a numerical base and x is a floating point value, Wallschlaeger describes that attenuation values are scaled line integrals or scaled

logarithms of the relative intensities, and Watson describes that a bisection method is used to increment or decrement a matrix, wherein the bisection method includes establishing a range for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255, a perceptual error matrix $p_{u,v,\theta}$ is then evaluated at midpoint of the range. For the reasons set forth above, Claim 15 is submitted to be patentable over Smith in view of Wallschlaeger and further in view of Watson.

Claims 24-25 depend, directly or indirectly, from independent Claim 15. When the recitations of Claims 24-25 are considered in combination with the recitations of Claim 15, Applicants submit that dependent Claims 24-25 likewise are patentable over Smith in view of Wallschlaeger and further in view of Watson.

For the reasons set forth above, Applicants respectfully request that the Section 103 rejections of Claims 10-11 and 24-25 be withdrawn.

Claims 12-14 and 26-28 were indicated as being allowable if amended to incorporate the recitations of the base claim and any intervening claims. Claims 12-14 depend, directly or indirectly, from independent Claim 1 which is submitted to be in condition for allowance. When the recitations of Claims 12-14 are considered in combination with the recitations of Claim 1, Applicants submit that dependent Claims 12-14 are also in condition for allowance.

Claims 26-28 depend, directly or indirectly, from independent Claim 15 which is submitted to be in condition for allowance. When the recitations of Claims 26-28 are considered in combination with the recitations of Claim 15, Applicants submit that dependent Claims 26-28 are also in condition for allowance.

Claims 29 and 30 are newly added. Claim 29 depends directly from independent Claim 1 which is submitted to be in condition for allowance. When the recitations of Claim 29 are considered in combination with the recitations of Claim 1, Applicants submit that dependent Claim 29 is also in condition for allowance.

Claim 30 depends directly from independent Claim 15 which is submitted to be in condition for allowance. When the recitations of Claim 30 are considered in combination with the recitations of Claim 15, Applicants submit that dependent Claim 30 is also in condition for allowance.

In view of the foregoing amendments and remarks, all the claims now active in this application are believed to be in condition for allowance. Reconsideration and favorable action is respectfully solicited.

Respectfully Submitted,

Thomas M. Fisher
Registration No. 47,564
ARMSTRONG TEASDALE LLP
One Metropolitan Square, Suite 2600
St. Louis, Missouri 63102-2740
(314) 621-5070

Express Mail No. EV 263879158 US

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Min Xie et al.	:	
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	:	
For: METHOD AND APPARATUS FOR FAST NATURAL LOG(X) CALCULATION	:	

SUBMISSION OF MARKED UP PARAGRAPHS AND CLAIMS

Hon. Commissioner for Patents
Washington, D.C. 20231

Submitted herewith are marked up paragraphs in accordance with 37 C.F.R. 1.121(b)(1)(iii) and marked up Claims in accordance with 37 C.F.R. 1.121(c)(1)(ii), wherein additions are underlined and deletions are [bracketed].

IN THE ABSTRACT

[The present invention is, in one embodiment, a] A method for computing a natural logarithm function [that includes steps of:] includes partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions; precomputing centerpoints a, of each of the N equally spaced sub-regions, where $i=0,\ldots,N-1$; selecting N sufficiently large so that, within each sub-region, a first degree polynomial in m computes $\log(m)$ to within a preselected degree of accuracy for any m within the sub-region, where m is a mantissa of a binary floating point representation of a number; and computing a value of $\log(x)$ for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m.

[This embodiment of the present invention and others described herein reduce the complexity of approximations used to calculate natural logarithms while achieving numerical accuracy consistent with IEEE floating point precision.]

IN THE SPECIFICATION:

At page 7, line 3:

$$[\text{error}]\underline{\text{error}} \le \frac{1}{2a_i^{\,2}} \times \left(\frac{1}{2N}\right)^2; \ i = 0,\ldots,N-1; \ 1 \le a_i < 2 \qquad (7a)$$

At page 7, line 14:

$$b_i = -\log(a_i) + \left(\frac{1}{4a_iN}\right)^2 - \left(1 + \frac{1}{2N}\right)\frac{1}{a_i}\underline{\text{; and}} \qquad (9)$$

$$\underline{c_i = -1/a_i.}$$

IN THE CLAIMS

1. (once amended) A method for computing an approximation of a natural logarithm function comprising the steps of:

[partioning] partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions;

precomputing centerpoints a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$;

selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes $\log(m)$ to within a preselected degree of accuracy for any m within the sub-region, where m is a mantissa of a binary floating point representation of a number; and

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computing a value of $\log(x)$ for a binary floating point representation of a particular number x stored in a memory of a computing device utilizing the first degree polynomial in m.

4. (once amended) A method in accordance with Claim 2 wherein computing an approximation to $\log(x)$ comprises the step of computing an approximation written as:

$$y = -\log(x) \approx b_i + c_i \Delta x + ex \log(2)$$
$$for\ i = 0, \ldots, N-1$$

where:

$$[b_1]\underline{b_i} = -\log(a) + \left(\frac{1}{\cancel{[4a_1 N]}\underline{4a_i N}}\right)^2 - \left(1 + \frac{1}{2N}\right)\frac{1}{[a_1]\underline{a_i}}; \text{and}$$
$$[c_1]\underline{c_i} = -1/a_i.$$

12. (once amended) A method in accordance with Claim 10 wherein computing an approximation to $\log(x)$ comprises the step of computing an approximation written as:

$$y = -\log(x) \approx b_i + c_i \Delta x + ex \log(2)$$

$$for\ i = 0, \ldots, N-1$$

where:

$$[b_1]\underline{b_i} = -\log(a) + \left(\frac{1}{[4a_1 N]\underline{4a_i N}}\right)^2 - \left(1 + \frac{1}{2N}\right)\frac{1}{[a_1]\underline{a_i}}; \text{and}$$
$$[c_1]\underline{c_i} = -1/a_i.$$

18. (once amended) A computing device in accordance with Claim 16 wherein said device being configured to compute an approximation to $\log(x)$ comprises said device being configured to compute an approximation written as:

$$y = -\log(x) \approx b_i + c_i \Delta x + ex\log(2)$$

$$for\ i = 0,\ldots,N-1$$

where:

$$[b_1]\underline{b_i} = -\log(a) + \left(\frac{1}{[4a_1N]\underline{4a_iN}}\right)^2 - \left(1+\frac{1}{2N}\right)\frac{1}{[a_1]\underline{a_i}};\text{and}$$

$$[c_1]\underline{c_i} = -1/a_i.$$

26. (once amended) A computing device in accordance with Claim 24 wherein said device being configured to compute an approximation to log(x) comprises said device being configured to compute an approximation written as:

$$y = -\log(x) \approx b_i + c_i \Delta x + ex\log(2)$$

$$for\ i = 0,\ldots,N-1$$

where:

$$[b_1]\underline{b_i} = -\log(a) + \left(\frac{1}{[4a_1N]\underline{4a_iN}}\right)^2 - \left(1+\frac{1}{2N}\right)\frac{1}{[a_1]\underline{a_i}};\text{and}$$

$$[c_1]\underline{c_i} = -1/a_i.$$

Respectfully Submitted,

Thomas M. Fisher
Registration No. 47,564
ARMSTRONG TEASDALE LLP
One Metropolitan Square, Suite 2600
St. Louis, Missouri 63102-2740
(314) 621-5070